SEPARATION OF AROMATIC FROM ALIPHATIC BY USING [EIM][$EtSO_4$] IONIC LIQUID

CHE AHMAD ARIF BIN CHE MUD

Thesis submitted in partial fulfilment of the requirements
for the award of the degree of
Bachelor of Chemical Engineering (Gas Technology)

Faculty of Chemical & Natural Resources Engineering
UNIVERSITI MALAYSIA PAHANG

JULY 2013

ABSTRACT

The separation of aromatic from the aliphatic hydrocarbon mixtures are very challenging since these hydrocarbons have boiling point in a close range and several combination form an azeotrope. Toluene and *n*-heptane are known to have a very close boiling point, thus difficult to separate by fractionation with distillation. The present studies focusing on separating toluene from *n*-heptane using 3-ethylimidazolium-ethylsulfate [EIM][$EtSO_4$]. From the analysis of data by using the FTIR and HPLC, the functional group of ionic liquid can be determined as amine group and for the analyzing the data for the extraction, the removal of the toluene from the mixture shows the positive results where the toluene was separated from the aromatic/aliphatic mixtures increases and it depends on the amount or percentages of the volume ratios of the toluene compound in the mixtures. From the results of stirring, it shows that the distribution coefficient of toluene was decreasing with the increasing of the removal of the toluene from the toluene/n-heptane and the selectivities at the temperature 30°C was increasing with decreasing toluene content in the feed.

Keywords: *Separation, Toluene/n-Heptane mixture, Azeotrope, Ionic Liquids, 3-ethylimidazolium-ethylsulfate [EIM][$EtSO_4$]*

ABSTRAK

Pemisahan aromatik daripada campuran hidrokarbon alifatik sangat mencabar kerana hidrokarbon mempunyai takat didih dalam julat yang rapat dan beberapa bentuk gabungan azeotrope. Toluena dan n-heptana diketahui mempunyai takat didih yang sangat rapat, oleh itu sukar untuk memisahkan pemeringkatan dengan penyulingan. Kajian ini memberi tumpuan kepada memisahkan toluena daripada n-heptana menggunakan 3-ethylimidazolium etil-sulfat [EIM][EtSO4]. Daripada analisis data dengan menggunakan FTIR dan HPLC, kumpulan berfungsi bagi cecair ionik boleh ditentukan sebagai satu kumpulan amine dan untuk menganalisis data untuk pengekstrakan, penghapusan toluena daripada campuran menunjukkan hasil yang positif di mana toluene adalah dipisahkan daripada campuran aromatik / alifatik bertambah dan ia bergantung kepada jumlah atau peratusan nisbah jumlah kompaun toluena dalam campuran. Daripada keputusan mengacau campuran, ia menunjukkan bahawa pekali taburan toluena telah berkurangan dengan peningkatan penyingkiran toluene dari campuran toluena / n-heptana dan selectivities pada suhu 30 ° C telah meningkat dengan mengurangkan kandungan toluena dalam suapan.

Keywords: *Pemisahan, Campuran Toluene/n-Heptana, Azeotrope, Cecair Ionik, 3-ethylimidazolium-ethylsulfate [EIM][EtSO$_4$]*

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

n-heptane	normal heptane
°C	Degree Celcius
°F	Degree Farenheit
i-octane	iso octane
wt %	weight percent
v/v %	volume ratio percent
g	gram

LIST OF ABBREVIATIONS

VOC	Volatile Organic Compound
ILs	Ionic Liquids
FTIR	Fourier Transform Infra Red
HPLC	High Performance Liquid Chromatography
IFP	Institute Francies du Petrole
S	Selectivity
D	Distribution Coefficient
IR	Infra Red
RPM	Rotation per Minute

1 INTRODUCTION

1.0 Motivation and statement of problem

In the chemical industries, toluene and n-heptane are widely used in the processing and manufacturing. Toluene is a compound that occurs naturally in the crude oil in the very low level of the oil separation. This chemical also is a by product in the production in gasoline and coke fuel from the coal.

Compared with the other chemical, n- heptane is a chemical from the aliphatic group with the straight chain of alkanes. This chemical usually used and applied in the laboratories as a totally non- polar solvent and it also used as a fuel component in anti knock test engine. Because of the separation between two components are very challenging since these hydrocarbons have slightly different in the boiling point and several combinations form an azeotrope, common process like separation by fractionation with distillation become more difficult. To overcome this problem, the present studies found that the separation between this aliphatic and aromatic compound can be accomplished by separating by using ionic liquids (Meindersma *et al*., 2005).

1.0.1 Toluene

Toluene was used widely in processing and producing the product. With the characteristic of the aromatic hydrocarbon group, toluene is a chemical that are clear and colourless liquid with a strong sweet and pungent odour. According to Alelsto (2008), with the chemical formula C_7H_8, this compound occurs naturally in the crude oil though in very low levels and it also a by product in the production gasoline and coke fuel from the coal. Actually, this liquid is typically stable under the normal usage and storage condition but it will become danger when the container was heated or subjected to high temperature and mishandling because it may burst and cause explosions. Toluene is a chemically incompatible with strong oxidizing agents, sulfuric and nitric acids, and chlorine. When the toluene was heated and react with the nitro group, toluene can changed to di-nitro toluene and eventually into the volatile and explosive tri-nitro toluene. This thing can reacts strongly with the oxidizing agents and it may produce heat or can potentially ignite or explode when it not handled carefully and it was written by Canadian Centre for Occupational Health & Safety (2008).

This aromatic compound that are also known as volatile organic compound (VOC) which had the application in industries was proven with the achievement especially in production of benzene because this chemical was used to make plastics and synthetic fibers and also was used to boost the octane of gasoline. Other application of this compound are used as a solvent and to make aviation of gasoline, spray and wall paints, paints thinner, medicine, dyes, explosives, detergents and others. It is also used in some printing and leather tanning processes.

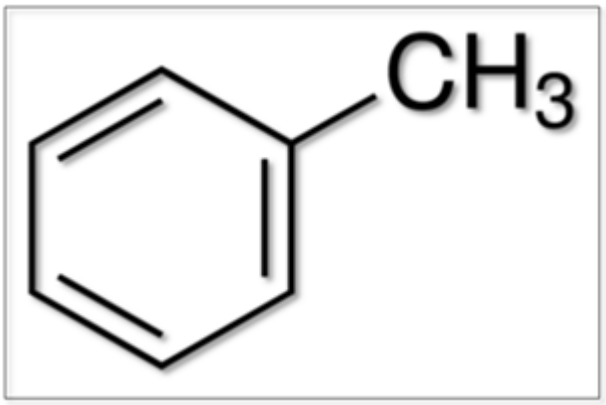

Figure 1.1 Toluene structure

Table 1.1 Physical properties and explosion data for the Toluene.
(Toluene MSDS, Science Lab.Com)

Chemical Name	- Toluene, Methylbenzene - Toluol - Phenyl- methane - Methyl- benzol
Chemical Formula	- C6-H5-CH3 or C7H8
Flammability of the products	- Flammable
Auto- Ignition Temperature	- 480°C or 896 °F
Flammable Limit	- LOWER 1.1 % and UPPER 7.1%
Physical state and appearance	- Liquid state with sweet, pungent, benzene like odor.
Molecular Weight	- 92. 14 g/ mole
Color	- Colourless
Boiling Point	- 110.6 °C or 231.1 °F
Melting Point	- - 95 °C or -139 °F
Specific Gravity	- 0.8636 (water =1)

1.0.2 Heptane (n- Heptane)

Heptane or n- Heptane is one of the aliphatic groups with the straight chain of alkane with the chemical formula C_7H_{16}. This hydrocarbon had nine isomers with different type of structure are widely used and applied in the laboratories as a totally non- polar solvent. When this hydrocarbon used as a test fuel component in anti knock test engine, a 100 percent of heptanes fuel is the zero point of octane rating scale where the 100 point is a 100 percent of i-octane. The numbers of octane in the ratios between octane and heptanes equates to anti-knock qualities which are expressed as the percentage of iso-octane in heptanes and listed on pumps for the gasoline where are dispensed in the US and internationally.

In state of liquid, this hydrocarbon it is really ideal for transport and storage. For the test like grease spot test, heptanes is used as a liquid to dissolve the oil spot to show the previous presence of the organic compounds on a stained of paper by shaking it in the heptanes solution for about half minute. In other uses, the liquids are commercially available as mixed isomers for use in paints and coating. For examples, n-haptane was use as the rubber cement solvent “Bestine”, the outdoor stove fuel, and for the pure n-Heptane was used for the research and development and also for the pharmaceutical manufacturing and as a minor component in gasoline.

In gasoline, heptanes one of primary reference fuels for the determination of the gasoline octane number. Consequently, the research community for the combustion has endeavoured to develop in detailed in chemical kinetics mechanism for the combustion of heptanes. For the mechanism combustion of heptanes, the oxidation of this hydrocarbon has been investigate in shock tubes, jet stirred reactor, premixed and diffusion flame (Zhuko *et al*., 2004).

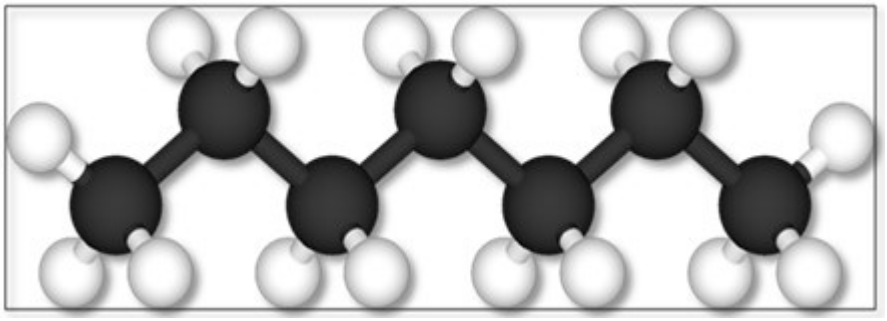

Figure 1.2 Normal heptane (n- Heptane) structures.

Table 1.2 Physical properties and explosion data for the n-Heptane.
(n- Heptane MSDS, Science Lab.Com)

Chemical Name	- n- Heptane - Dipropyl methane - Heptyl hydride
Chemical Formula	- C_7H_{16}
Flammability of the products	- Flammable
Auto- Ignition Temperature	- 203.89 °C or 399 °F
Flammable Limit	- LOWER 1.05 % and UPPER 6.7%
Physical state and appearance	- Liquid state with gasoline like odor
Molecular Weight	- 100. 21 g/ mole
Color	- Clear colorless
Boiling Point	- 98.4 °C or 209.1 °F
Melting Point	- - 90.7 °C or -131.3 °F
Specific Gravity	- 0.6838 (water =1)

1.0.3 Separation of Azeotropic Combination.

An azeotrope is a mixture two or more liquids in such a way that its components cannot be altered by simple distillation (Moore &Walter., 1962). In the industries, the presents the azeotropes alter the product distribution and it also restricted the separation amount of the multi- component mixtures that can be achieved by distillation (Okasinski & Doherty., 1997). The azeotrope phenomenon can occur in reactive and in non- reactive mixture and they can be classify as homogeneous and heterogeneous depending on the number of liquids phases involved in the equilibrium condition. Like the non- reactive mixtures, the homogeneous azeotrope happen when the composition of the vapor liquid phases at equilibrium is identical and it also same for the reactive mixture but this system were using reaction invariant composition space (Moore & Walter., 1962).

In separation aromatic hydrocarbon (benzene, toluene, ethyl benzene and xylenes) and aliphatic hydrocarbon that are from C_4 to C_{10} group, it will be more challenging since these two hydrocarbons have boiling point on close range and several combination form an azeotrope. There are some conventional processes that was practice in the industries for the liquid separation process such as liquid extraction where it suitable for the range 20- 65 percent of aromatic contents, extractive distillation for the range 65- 90 percent aromatic and azeotrope distillation for the high aromatic content which are more than 90 percent in the feeds. But according to Weissermel and Arpe (2003), there are no feasible processes that are available for the separation of aromatic and aliphatic hydrocarbon in the range below 20 percent aromatic in the feed mixture. From the preliminary calculation, the result shows that, extraction with conventional solvents are not an option since additional separation step are required to purified the raffinate, extract and solvent streams which may cause high investment and energy.

According to Meindersma (2005 & 2007), the other alternative to separate both group of hydrocarbons is extraction using ionic liquids. The application of ionic liquids in extraction process is promising because of their non- volatile in nature. For the separation unit, the solvent recovery facilities for this process are using techniques as simple as flash distillation or stripping where the extraction of aromatic from mixed

aromatic and aliphatic streams with the ionic liquids are expected to require less process steps and less energy consumption compare to the extraction with conventional solvents because ionic liquids have a negligible vapor pressure, it can be recover back by evaporating the extracted hydrocarbon from the ionic liquid phase.

Table 1.3 The structure of the data bank derived from the case study from system of aromatic/ n-alkane. (Korean, J. of ChemEng, 1995)

Formula	Name	Formula	Name		Group	Group	Press. (Mpa)	T_a [°C]	T_1 [°C]	T_2 [°C]	ΔT [°C]
C8H18	OCTANE	C6H6	BENZENE	NON	N-ALKANE	AROMATIC	0.10130	0.000	125.75	80.10	-45.65
C7H16	HEPTANE	C6H6	BENZENE	AZE	N-ALKANE	AROMATIC	0.10130	80.100	98.40	80.10	-18.30
C8H18	OCTANE	C7H8	TOLUENE	NON	N-ALKANE	AROMATIC	0.10130	0.000	125.75	110.70	-15.05
C9H20	NONANE	C8H10	ETHYL BENZENE	NON	N-ALKANE	AROMATIC	0.10130	0.000	150.70	136.15	-14.55
C9H20	NONANE	C8H10	P-XYLENE	NON	N-ALKANE	AROMATIC	0.10130	0.000	150.70	138.40	-12.30
C9H20	NONANE	C8H10	O-XYLENE	AZE	N-ALKANE	AROMATIC	0.10130	144.250	150.70	143.60	-7.10
C9H20	NONANE	C8H8	STYRENE	AZE	N-ALKANE	AROMATIC	0.10130	144.000	150.70	145.00	-5.70
C9H20	NONANE	C9H12	CUMENE	AZE	N-ALKANE	AROMATIC	0.10130	148.000	150.70	152.80	2.10
C8H18	OCTANE	C8H10	ETHYL BENZENE	AZE	N-ALKANE	AROMATIC	0.10130	125.600	125.75	136.15	10.40
C6H14	HEXANE	C6H6	BENZENE	AZE	N-ALKANE	AROMATIC	0.10130	68.500	68.95	80.10	11.15
C7H16	HEPTANE	C7H8	TOLUENE	NON	N-ALKANE	AROMATIC	0.10130	0.000	98.40	110.70	12.30
C8H18	OCTANE	C8H10	P-XYLENE	NON	N-ALKANE	AROMATIC	0.10130	0.000	125.75	138.40	12.65
C7H16	HEPTANE	C8H10	ETHYL BENZENE	NON	N-ALKANE	AROMATIC	0.10130	0.000	98.40	136.15	37.75
C7H16	HEPTANE	C8H10	P-XYLENE	NON	N-ALKANE	AROMATIC	0.10130	0.000	98.40	138.40	40.00
C6H14	HEXANE	C7H8	TOLUENE	NON	N-ALKANE	AROMATIC	0.10130	0.000	68.95	110.70	41.75
C5H12	PENTANE	C6H6	BENZENE	NON	N-ALKANE	AROMATIC	0.10130	0.000	36.15	80.10	43.95

T_a : azeotrope temperature
T_1 : normal boiling point of component 1
T_2 : normal boiling point of component 2
ΔT : the difference of the normal boiling points ($T_2 - T_1$)
AZE : binary azeotrope
NON : nonazeotrope

1.1 Objectives

In performing the extraction of the aromatic aliphatic hydrocarbon using imidazolium base ionic liquid 3-ethylimidazolium-ethylsulfate [EIM][$EtSO_4$], this research has highlighted two objectives which are:

- To study and characterized the ionic liquid.
- To analyze the content of aromatic from aliphatic hydrocarbon after the extraction.

1.2 Scope of this research

This research focus on the main scope to experimentally investigate the effectiveness of the imidazolium based ionic liquid in extraction of the aromatic hydrocarbon group from aliphatic hydrocarbon group.

1.3 Main contribution of this work

It is very efficient to separate or extract the aromatic hydrocarbon from aliphatic hydrocarbon by using ammonia base ionic liquid because of the step that needs to achieve the separation is less and the recovery facilities for this process are using technique ad simple as flash distillation or stripping compare to the other conventional separation that need more equipment and steps. Other than that, because of ionic liquids have a negligible vapour pressure, it can recovered back by evaporating the extracted hydrocarbon from the ionic liquid phase and this process promising less investment cost and also energy consumptions.

1.4 Organisation of this thesis

The structure of the reminder of the thesis is outlined as follow:

Chapter 1 is the introduction of the researched. This chapter provide provides the motivation and problem statement of this research. In order to define the problem of the mixture of aromatic and aliphatic mixture, the properties and application of the toluene and n-heptane was being study and analyzed. The separation of azeotropic combination between the mixtures is the one of the major problem in this research that was highlighted and need to studies.

Chapter 2 provides a description of the applications and general knowledge for the extraction of aromatic/aliphatic mixture. This chapter also provide the several types of ionic liquids that used in the industries which are about the anion and cation for the effectiveness for separation of aromatic from aliphatic compound. In the chapter 2 also provide the some knowledge about the ionic liquid that used in this experiment and also the equipment to analyze the functional group in the ILs.

Chapter 3 gives a review of the FTIR and HPLC approach applied for analyzing the ionic liquids and also the sample. In analyzing the samples and also developing the calibration curve, the HPLC equipment needs to be setup to fulfil the standard for detected the samples to analyze the results that was developed.

Chapter 4 is the results and discussion part where the data was analyzed to achieved the objectives of this experiment and also to discuss the results that collected from the analysis of samples. In this chapter, the result was compared to the prediction from the common method for solving the problems. The details explanation of the results that was used to analyze the sequences that happen to the results is also outlines.

Chapter 5 draws together a summary of the thesis and outlines the future work which might be derived from the model developed in this work.

2 LITERATURE REVIEW

2.0 Overview

This paper presents the experimental studies of the separation of the aromatic hydrocarbon from aliphatic hydrocarbon mixtures that are very challenging since this hydrocarbon had boiling points in a closed range and several of the combination of hydrocarbon form azeotropes. There are several conventional processes in industries for the separation aromatic/aliphatic hydrocarbon mixtures. Different process will separate different range of weight percent (wt %) like liquids extraction suitable for the range of 20-65 wt % aromatic content, extractive distillation for the range of 65-90 wt % aromatics and azeotropic distillation for the high content which are for more than 90 wt %. According to Weissermal and Arpe (2003), there is no feasible processes are available for the separation aromatic/aliphatic mixture in the range below 20 percent aromatics and because of the selectivity and activity coefficient of the aromatic/aliphatic mixture, the ionic liquid was suggested for the extractions. The application of ILs for the extraction processes are promising because of their non volatile nature and require less step and energy consumption because it had a negligible vapour pressure (Meindersma *et al*., 2005).

2.1 Ionic Liquids

Extraction of aromatic from mixed aromatic and aliphatic streams with the ionic liquids are expected to require less process steps and less energy consumption compare to extraction with conventional solvents because ionic liquids have a negligible vapor pressure (Meindersma *et al*., 2005). In development of extraction solvent, ionic liquids offer new opportunities. The ionic liquids that has known today are based on the different large, which are the organic cation combined with a great variety of organic and inorganic anions. Compared with other solvent like molecular solvent, ionic liquids have advantages of being liquids over a wide range of temperature and having a non-volatile nature.

The latter property has been the reason to call ionic liquids as a green solvent and to start the development as a alternative, environmental friendly solvents. Actually the

properties of the ionic liquids are determined by the combination of the cation and anion. Due to the large number of possible ion combination which gives the opportunity to tailor a specific solvent for a particular separation, ionic liquids are also called designer solvents. Recently, the ionic liquids become more famous and gained more interest for many different fields of application. From the journal that was written by Maase (2008), he suggested the ionic liquids need to classified for the process chemical, performance chemical and also for engineering fluids.

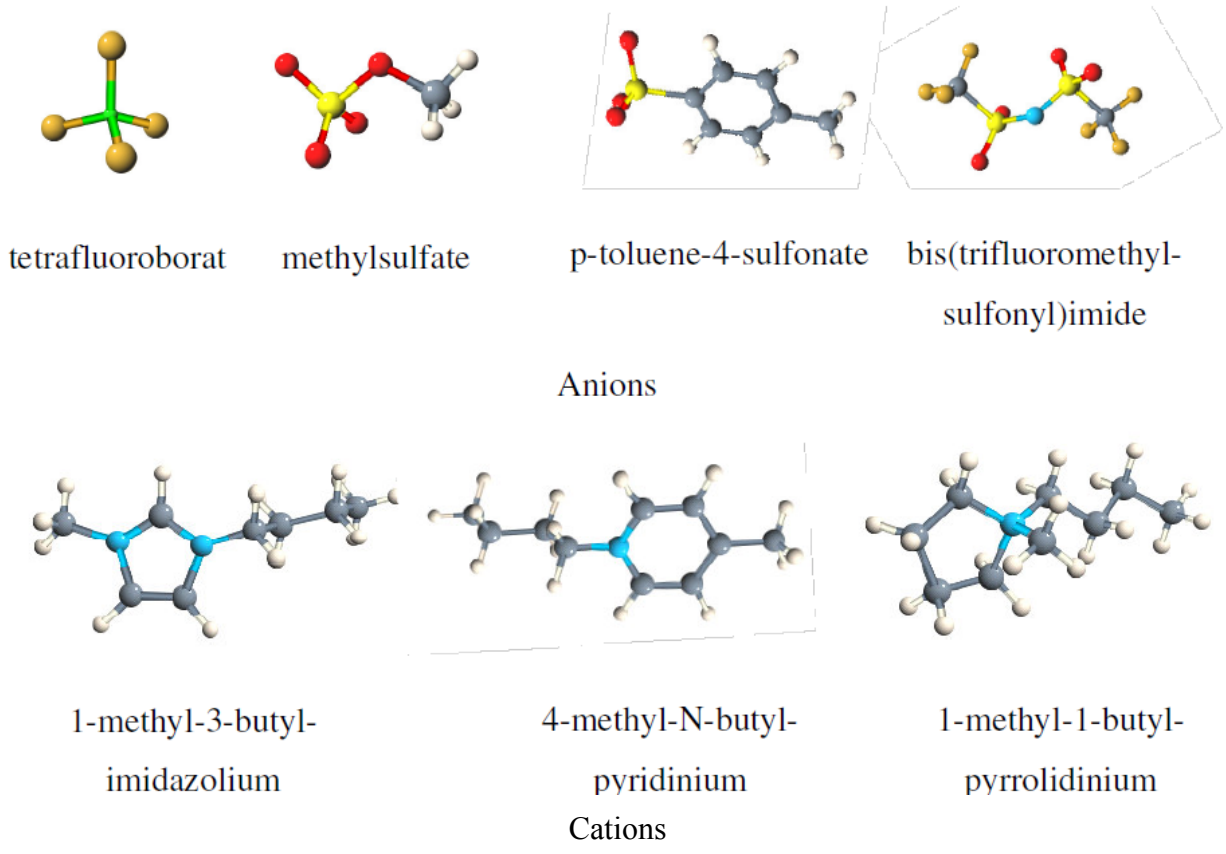

Figure 2.1 Typical ionic liquids anions and cations. (Hansmeier, 2010)

Actually this ionic liquid has been mentioned for the first time in the open literature in 19 century. Ionic liquids develop mainly by the electrochemists in their researched of ideal electrolytes for batteries, that has been used initially for those that are related application like semiconductor (Oliver and Magna, 2002). According to Wilke and Zaworotko (1992), in 90's, the first water stable ionic liquids was reported, the signal had been given for many other applications outside the field of

electrochemistry. Difasol, the first ionic liquid based process on the pilot scale has been the dimerization of olefins with biphasic that are homogeneous catalyst developed by the *Institute Française du Pétrole (IFP)* (Weyershausen & Lehmann, 2005).

In selection of the ionic liquids for the separation of the aromatic from aliphatic hydrocarbon need to give more intentions. The selection of the ionic liquid has been made according to the hypothesis from the journal that has been written by Hansmeier (2010). From the hypothesis, the cation such as imidazolium, pyridinium, and pyrrolidinium are suitable cation where this thing a not aromatic in nature. For the selection of anions, they are typically small, linear components with the explicit charge distribution like dicyanamide, thiocyanate, tetracyanoborate and tricyanomethanide.

Table 2.1 Overview theoretically suitable and unsuitable cations and anions.

	Cation	Anion
Suitable	$[MMIM]^+$	$[AlCl_4]^-$
	$[BMIM]^+$	$[PF_6]^-$
	$[EMIM]^+$	$[BF_4]^-$
	$[H_6MIM]^+$	$[SCN]^-$
	$[OMIM]^+$	$[DCA]^-$
	$[bupy]^+$	$[TCM]^-$
	$[Mebupy]^+$	$[TCB]^-$
	$[Meethpyrr]^+$	
	$[Mebupyrr]^+$	
	Sulfolane	
Unsuitable	$[Ammonium]^+$	$[Tf_2N]^-$
	$[Phosphonium]^+$	$[sulfates]^-$
	$[Sulfonium]^+$	$[sulfonates]^-$
	$[Quinolinium]^+$	$[tosylate]^-$
	$[Guanidium]^+$	$[Cl]^-$
		$[I]^-$
		$[Br]^-$
		$[phosphates]^-$
		$[trifluoroacetate]^-$

2.2 Extraction Based on Ionic Liquids

Extraction of aromatics from the mixed aromatic and aliphatic hydrocarbon streams with the ionic liquids are expected to required less process step and less the energy consumption. Differences separation of aromatic/aliphatic mixture by using extraction with ionic liquid and conventional solvent, ionic liquid had a negligible vapour pressure and has different behaviour in capacity depending on the aromatics concentration compared to solvent like sulfolane (Meindersma *et al*., 2005). Other than that, because of the properties of ionic liquids are non- volatile nature, the extraction processes are really promising and the facilities solvent recovery as simple as flash distillation or stripping. According to Meindersma *et al*. (2005), the requirements of suitable extraction solvent for the separation of aromatic and aliphatic hydrocarbon are:

- High solubility of aromatic hydrocarbons in the ILs.
- No or low solubility of aliphatic hydrocarbon in the ILs.
- High separation factor and a high distribution coefficient.
- Simple recovery of the ILs from both the extract and raffinate phase.
- Fast mass transport from the feed phase to the ILs phase.

Toluene from aromatic hydrocarbon and heptane from the aliphatic hydrocarbon group was chosen as a model for the separation between aromatic/ aliphatic hydrocarbon. According to Weissermal and Arpe (2003), no feasible processes are available for the separation of aromatic and aliphatic hydrocarbon in the range below 20 percent of aromatic in the feed mixture. Because of that reason, the large number of ionic liquids with different cations and anions were tested with a mixture of 10 (v/v) percent toluene in heptane as a reference for the selection of suitable ionic liquids for the separation (Meindersma *et al*., 2007). Extraction of this hydrocarbons experiment will be performed with the most suitable ionic liquid. In the industries, sulfolane are conventional in extraction processes because of that reason this solvent are used as a benchmark for this separation ($S_{tol/hep}$= 30.9, D_{tol}=0.31 at 40 °C). To make sure this experiment come out with the good results, the suitable ionic liquids for this separation must show $S_{tol/hep} \geq 30.9$, $D_{tol} \geq 0.31$.

Aromatics hydrocarbon has low activity coefficients at infinite solution in several ionic liquids. Krummen *et al* (2002) have measured activity coefficient at infinite dilution for several solutes in ionic liquids like [mmim]Tf_2N, [emim]Tf_2N, [bmim]Tf_2N and [emim] ethyl-sulfate. From the data that was collected from the activities, the distribution coefficient and selectivity of these solutes can be calculated. From the calculations that was performed, the results showed that the ionic liquid [emim] ethylsulfate have highest selectivity where S=36.4 at 40 °C for separation toluene/ n-heptane, where the selectivity higher than selectivity from sulfolanes (Krummen et al., 2002). For the ionic liquids like [bmim]Tf_2N, it showed a lower selectivity but had higher capacity or distribution coefficient than the ILs with the cation $[emim]^+$ and $[mmim]^+$. This result also showed when do the separations for the aromatic/aliphatic hydrocarbon like benzene/cyclohexanes and benzene/hexane. From this data also, it can be conclude that the length of the R-group also affected because the shorter the R-group, it favourable for the aromatic/aliphatic hydrocarbon selectivity but it will decrease in the capacity.

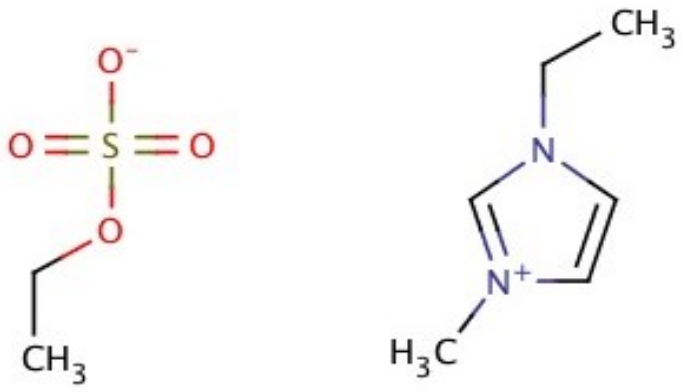

Figure 2.2 3-ethylimidazolium-ethylsulfate structures.

Table 2.2 Physical and chemical properties 3-ethylimidazolium-ethylsulfate ([EIM][$EtSO_4$]). (Material Safety Data Sheet, 2009)

General Information	
Form	Liquid
Colour	Pale Yellow
Odour	Not determine
Change in condition	
Melting point/Melting range	Less than -30°C
Boiling point/Boiling range	Not determined
Sublimation temp/ start	Not determined
Flash point	162°C
Ignition temperature	Not determined
Decomposition temperature	Not determined
Danger of explosion	Do not present an explosion hazard
Explosion limit	
Lower	Not determined
Upper	Not determined
Vapor pressure	Not determined
Density at 20°C	1.24 g/cm^3

2.3 Fourier Transform Infra- Red Spectroscopy (FTIR)

Fourier transform infrared spectroscopy is the one method to analyze the sample in industries. This technique is to obtain an infrared spectrum of some phenomenon like absorption, emission, photoconductivity or Raman scattering of solid, liquids or gas. An FTIR spectrometer simultaneously collects spectral data in wide range. In this spectroscopy, IR radiation is passed through a sample and some of the infrared radiation is absorbed by the sample and some of it will pass through the transmitter. From the results, spectrum that developed will represents the molecular absorption and transmission, creating a molecular fingerprint of the sample. Like a fingerprint no two unique molecular structures was produce at the same infrared spectrum. Because of the FTIR ability, that makes this spectroscopy useful for several types of analysis like: